PROGRESS REPORTS

FROM

EXPERIMENT STATIONS

SEASON 1958-59

NORTHERN NIGERIA

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E.C.G.C. STAFF LIST

SAMARU, ZARIA PROVINCE

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GOMBE, BAUCHI PROVINCE

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NORTHERN NIGERIA

PROGRESS REPORT FOR THE SEASON 1958-59

Planting period: June to September.

Picking period: November to March.

Close season: April to June.

General Introduction

BY

H. E. KING

Season and General

This season differed strikingly from the last. The incidence of early rains was unfavourable for the timely planting and the establishment of food crops and, in consequence, the planting of a great part of the commercial cotton crop was also delayed—extremely so in many places.

Rains subsequent to crop establishment were also poorly distributed, there being in particular a severe drought during July and August in parts of the Riverain Provinces and an early finish to the rains in much of the North. Seasonal rainfall totals were, in general (though not everywhere), well below average.

In consequence, in most areas yields were much below last season's and the total commercial crop of Allen type cotton fell to 170,555 bales, representing 10·42 bales per ton of seed issued in contrast to last season's record figure of 14·89.

This lower rainfall was experienced at both Samaru and Daudawa but, in contrast to the commercial crop, timely planting was still achieved and record yields were obtained at both places. The 35 inches of rain recorded at Samaru proved adequate to bring timely planted crops to maturity while the greatly reduced incidence of surface flooding and the higher values for sunshine hours, associated with the low rainfall, can be counted as highly favourable to growth and to a large extent responsible for the quite unusually good early fruiting and boll setting which was a feature of almost the whole crop at Samaru and was also notable at Daudawa.

This early fruiting favoured the breeding of stainers (*Dysdercus* sp.), and damage by this pest was (as last season) more serious than in a "normal" year except where kept under control by insecticides. Red bollworm damage was also considerable but other insect pests, including mirids, were rather less conspicuous than usual.

Bacterial blight (*Xanthomonas malvacearum*) was far less prevalent than last season and was indeed difficult to find on many plots until quite late in the season.

TABLE 1.

SUMMARY OF SAMARU METEOROLOGICAL DATA FOR AND UP TO 1958.

Month	*Rainfall*		*Days rain*		*Relative humidity*				*Air temperature °F (screen)*				*Sunshine daily mean (hours) (i)*		*Open pan evaporation (inches) (ii)*	
	1958	1924 -58	1958	1938 -58	1958 *10 a.m.*	1958 *4 p.m.*	1954 -58 *10 a.m. Av.*	1954 -58 *4 p.m. Av.*	1958 *Max.*	1958 *Min.*	1938 -58 *Max.*	1938 -58 *Min.*	1958	1954 -58	1958	1954 -58
January	0·04	0·00	2	0·1	29·3	26·0	29·7	14·5	87·7	60·5	88·4	57·6	8·6	9·2	7·76	7·07
February	0·00	0·06	0	0·3	12·8	9·7	26·7	12·5	87·6	60·0	91·4	60·5	9·2	9·5	7·50	7·64
March	0·00	0·39	0	1·1	17·0	8·5	35·6	15·6	96·9	67·2	96·1	67·2	9·7	8·8	9·27	8·73
April	1·30	1·28	6	3·7	53·5	29·3	56·0	26·7	96·5	77·2	97·2	71·1	8·0	7·8	7·53	7·24
May	3·47	5·34	8	10·8	60·5	39·3	73·7	46·4	91·7	70·2	91·7	70·1	8·4	8·3	7·38	6·88
June	7·45	6·33	14	12·9	77·0	60·0	82·4	59·5	85·5	68·0	87·8	68·1	7·1	7·8	5·51	5·45
July	5·10	8·79	11	16·0	81·5	71·4	86·9	68·8	80·8	67·3	83·4	67·3	4·7	5·8	4·32	4·71
August	6·63	11·65	18	20·4	79·4	72·1	89·0	72·5	82·2	67·5	82·0	66·9	5·6	4·8	4·20	4·40
September	10·13	8·89	14	16·7	74·8	60·2	85·3	64·7	85·1	66·6	84·9	66·7	7·1	6·6	5·15	4·97
October	0·87	1·50	3	4·8	58·5	44·7	75·9	45·7	89·1	64·2	89·0	65·3	9·1	8·7	5·77	5·67
November	0·00	0·05	0	0·2	41·7	20·9	43·6	21·9	92·1	62·0	90·2	60·8	9·5	9·9	6·22	6·20
December	0·00	0·00	0	0·0	20·3	13·0	30·0	16·6	89·3	59·3	87·9	57·9	9·6	9·8	7·03	6·73
Totals	34·99	44·28	76	87·0	606·3	455·1	714·8	465·4	1064·5	790·0	1070·0	779·5	96·6	97·0	77·64	75·69
Mean	—	—	—	—	50·5	37·9	59·6	38·8	88·7	65·8	89·2	65·0	8·1	8·1	6·47	6·31

(i) Campbell-Stokes sunshine recorder.

(ii) From sunken tank 6′ × 6′; not corrected for errors due to splash.

Staff, Buildings and Land

Mr. King took leave in the United Kingdom from 7th April to 1st September 1958. Mr. Choyce returned from leave on 19th July 1958. Mr. Lee took leave from 26th May to 11th September 1958.

Mr. W. Reed arrived on appointment as entomologist (in replacement of Mr. Emsley) on 7th August 1958. Mr. Lawes proceeded on leave on 17th February 1959. Dr. M. Dransfield arrived at Samaru on 31st March 1959 to take up the post of plant pathologist, vacant since the death of Mr. H. M. Parker.

Mr. F. Tasker, previously a member of the junior staff of the section, was promoted to the post of Agricultural Superintendent in 1958 and took over responsibility for superintending much of the work of the section as well as carrying out some investigation of soil moistures himself.

The position as regards local junior staff showed no marked improvement, though the return of one member, absent for two years on a training course, was some help. The extension of the work of the section to include studies lying right outside the province of plant breeding, pathology and entomology (see section later on crop physiology) has strained the resources of the existing staff to the limit and indeed beyond—many of the experiments have suffered from inadequate supervision and incomplete recording.

No start has yet been made on the proposed new laboratories and both laboratory and storage space remain inadequate.

New land is now being opened up for experiments, which will reduce the need for intensive growing of successive crops of cotton.

Cotton Breeding

BY

H. E. KING, D. A. LAWES and B. J. S. LEE

Hybridization and Reselection

No new hybridization work was undertaken this season but the programme of reselection from hybrid material, including that produced by the panmixis method, was continued. Some reselections of promise were chosen for inclusion in replicated trials in the following season.

The panmixis bulk material, being grown annually at Gusau, Gombe and Kontagora, was again planted and left to produce seed by unrestricted natural pollination.

Straight reselection work within the Allen stocks was continued, but this season was confined almost entirely to a single strain, derived from the material which gave Samaru 26J, which promises a further yield advance but is below 26J in average lint length.

Work on this took two forms, one directed to the immediate production of a new bulk with higher mean halo length by the simplest possible method and the other a more elaborate procedure.

In the first, 300 good "on-type" single plant selections from a small bulk of the substrain 479-25 BCP/14-13 with a mean halo length of 33·5 mm. and a plant to plant range of 9·1 mm. (viz. from 28·3 to 37·4) were reduced to 50 plants with a mean of 34·6 mm. and a range of 1·9 mm. (34·0 to 35·9). The seed of these 50 plants was bulked for replicated trials in the following season.

The alternative procedure was applied to a field of about 5,000 plants of strain 479-25 BCP/14, from which 1,000 were selected at random and each subjected to laboratory examination in respect of nine characters, viz. bolls per plant, seed cotton per plant, seed cotton per boll, seeds per boll, lint per seed, lint per plant, seed weight, ginning percentage, and halo length.

In addition to studying each of these characters separately, and grouping the plants in certain ways, the correlations between the separate characters were investigated. The results, when fully digested and followed up by replicated field tests of progenies and small bulks, can be expected to include a large amount of highly valuable information.

Bulks carried forward from this work include groups of plants above and below the mean in respect of certain characters as well as a modal bulk.

Amongst the information already obtained from this work and of immediate practical interest is the range of variability in characters of economic importance. Lint lengths in particular showed a very wide range. The twenty plants with the longest lint gave an average halo length of 37·4 mm. and the 20 shortest an average of 30·9 mm.

The number of bolls per plant was very significantly negatively correlated with each of the three characters seeds per boll, seed weight and lint per seed—plants with a large number of bolls tended to have smaller bolls than plants with fewer, and these smaller bolls contained fewer and lighter seeds carrying less lint.

Replicated Progeny Row Test

A conventional replicated test of 47 progenies of Allen derivation was planted with selections from the previous season's progenies of two groups of material, of 479 and 49160 origin. The results were analysed in terms of components of yield and a selection index calculated. It was apparent, however, that the relative importance of the different components of yield was not the same for the two groups and a single selection index for the whole 47 progenies was not therefore appropriate.

Six progenies were chosen to carry forward as small bulks from the 479 group, and one only from the 49160 group since this, although having a high reputation for spinning quality, does not seem to contain the same yield potential as the 479 (which is that from which 26J was derived).

Tests of Small Bulks and Strains

Some useful results were obtained from these tests and several of the small bulks were chosen for further trial. From those which gave the best all-round performance, three were picked out to undergo larger scale tests.

District Variety Tests

The results this season from the series of district tests, ranging from Maiduguri to Kontagora, were disappointing. Plot to plot variation was excessive and the mean yields of the varieties were, in consequence, of low accuracy with apparent contradictions in the results from different sites. However, the slightly short-linted strain 479-25 BCP/14 which did so well in the previous season was again, on average, the highest yielder. The newest wave of Samaru 26J bulk stock and one substrain of extra lint length, 479-25-44/27, also both did well on the whole.

The spinning test results on samples of these are not yet to hand but it is, in any case, not intended to go further with the present stock of 479-25 BCP/14 since the large programme of reselection work on this strain (referred to previously) should yield a substrain of more definitely acceptable lint length and equal or even further improved yield.

Seed Multiplication

The large scale seed multiplication of Samaru 26J proceeded successfully and stocks were built up in the Southern Katsina and Gombe seed multiplication areas sufficient to provide over 60% of the planting seed requirements for the 1959-60 commercial crop.

Season 1960-61 should, therefore, see the complete replacement of Samaru 26C by the new strain.

Yields in the multiplication stages B and C at Daudawa, carrying the latest issue of Samaru 26J (the third wave), were extremely good. A yield per acre of over 1,000 lb. was recorded for the first time at that station. The control of stainers by repeated sprayings was an important factor in achieving this. Some fields left unsprayed gave much lower yields. Further details of this work are given in a later section.

Crop Physiology

BY

H. E. KING, D. A. LAWES and B. J. S. LEE

In continuation of the studies of crop growth of the previous few seasons, experiments and observations were again carried out making use of the fields of cotton planted primarily for small scale seed multiplication at Samaru.

The half acre field which last season gave 1,930 lb. of seed cotton per acre following a succession of treatments believed favourable to high yield was again manured, ridged and cross tied well before planting time and planted early with acid treated Agrosan dressed 26J seed. Superphosphate and sulphate of ammonia were again given by placement at planting, but last season's August application of urea was omitted. Mulching (this season with groundnut shell instead of dead grass) was done after the final September hoeing and DDT/BHC spray was applied eight times against last season's three.

The yield was 2,246 lb. of seed cotton per acre.

The most impressive feature of this result is that it was obtained in a season in which the rainfall was the lowest ever recorded at Samaru: only 22·7 inches were received subsequent to the planting of this crop.

A number of other experiments in which the same water conservation measures were included, but not the very high level of manuring nor the same frequent insecticide applications, are summarized in Table 2.

The gain in yield resulting from measures which assist in retaining rain on the land, and enable it to percolate into the soil more readily, was very marked in these experiments. An interesting feature is that the tying of alternate furrows gave (in two separate experiments) results as good as from the tying of every furrow.

The trial of early preparation of the land confirmed the benefit which this was previously believed to confer (it has indeed been practised as routine on land used for cotton breeding work but not previously, in this country, tested by replicated experiment).

There was once again evidence that groundnut shell is a more effective mulching agent than dead grass. One new measure—the splitting of the furrow bottom—was found to improve water penetration and increase yield.

The highly successful results of these measures directed to changing the rainfall—soil moisture—crop growth relationships have led to the diversion of a large proportion of the energies of the staff, both senior and junior, to the accumulation and analysis of data on rainfall, soil moisture, evapo-transpiration and leaf area. It has also stimulated

TABLE 2.

SUMMARY OF RESULTS OF FIELD TRIALS OF TREATMENTS INTENDED TO MODIFY SOIL MOISTURE—CROP RELATIONS.

Expt. No.	*Treatments*	*Yield lb. s.c. per acre*	*Increase over control*	
			lb. per acre	*%*
I	*Cross tying versus open furrows.*			
	Furrows cross tied.	878	158±19·8	22·0±2·75
	Furrows not cross tied (control).	720		
II	*Cross tying of furrows plus light mulching with groundnut shells.**			
	All furrows tied and mulched.	1035	242±68·8	30·5±8·67
	Alternate furrows tied and mulched.	1048	255±68·8	32·2±8·67
	Furrows neither cross tied nor mulched (control).	793		
III	*Cross tying of furrows plus light mulching with dead grass.**			
	All furrows tied and mulched.	924	139±58·6	17·8±7·46
	Alternate furrows tied and mulched.	922	137±58·6	17·4±7·46
	Furrows neither cross tied nor mulched (control).	785		
IV	*Splitting of furrow bottom with tine six weeks after planting.*			
	Splitting.	925	61±19·7	7·0±2·28
	No splitting (control).	864		
V	*Early (1st May) versus "late" (27th June) land preparation.*			
	Early.	973	125±25·4	14·7±2·99
	Late (control).	848		
VI	*Early versus "late" (2nd experiment on different site).*			
	Early.	683	137±28·6	25·1±5·25
	Late (control).	546		

*These experiments received 2 applications of insecticide dust.

planning the application of similar measures to land carrying other field crops at Samaru and the search for still other methods of achieving the same favourable results.

It was not possible to follow up the small supplementary watering experiment of last season by anything on a larger scale, but a repetition on comparable lines (but with three dates of planting) gave further evidence that, whereas a late planted plot responds markedly to additional water at the end of the rains, early July planted cotton shows only a slight response.

Entomology

by

M. A. Choyce and W. Reed

Introduction

The season was remarkable for the high yields given by cotton treated with insecticides; at four widely separated stations (Samaru, Daudawa, Shendam and Mokwa) yields of over 1,000 lb. per acre were obtained. It has become obvious that, under suitable conditions (which can be achieved only experimentally at present) the maximum yields possible in Northern Nigeria are of a similar order to yields from American type cotton in other countries.

The cotton stainer caused considerable damage to bolls set during September and October on early sown and well grown cotton, unless controlled by insecticides. Bollworms, particularly the red bollworm, and this and the pink bollworm in the Riverain areas, became common during October and November.

At Samaru, insecticides are being more generally used on cotton to enable the true effects of various cultural treatments to be determined. At Daudawa insecticides were successfully applied to 189 acres of multiplication cotton. In the Riverain areas, except at Lowlands, an abnormally long dry spell of up to seven weeks was a major factor in reducing the yields from insecticide trials.

Further information has been obtained on parasites of cotton bollworms and the occurrence of spider mite following the use of insecticide has been noted.

Incidence and Biology of Cotton Pests

Diparopsis watersi (*Roths.*). *Red bollworm.*—At Samaru emergence from observation troughs was again bimodal, some moths appearing in June, but the majority during October. At Gombe, emergence was apparently unimodal from May to July, with only a few during August. The low incidence of red bollworm on cotton in this area suggests that emergence in the field was similar to emergence from troughs.

An attempt is being made to correlate emergence from diapause with climatic factors, using data accumulated in recent years. A light trap is now in operation at Samaru, and it is hoped that this will yield further information on the times of flight of the moth.

Although all eggs from moths emerging in the laboratory proved infertile, eggs from the field were successfully hatched and reared to adults. The mean development rate under laboratory conditions was as follows:—egg, 5 days; 1st to 4th instars, 3 days each; 5th instar, 12 days; short-term pupa, 15 days. Since moths lay eggs on the first night after emergence, the total mean life cycle was 44 days.

The shortest life cycle recorded was 36 days (egg, 5 days; larva, 17 days; pupa, 14 days).

The extent and importance of natural control of red bollworm is being investigated. The most common parasite, *Carcelia evolans* (Weid.) (Diptera, Tachinidae), was found in 12% of all pupae collected at Samaru and Daudawa during 1958. In one small plot of cotton, where the bollworm population had been artificially boosted, the rate of parasitism increased to 60%. Attempts to persuade the fly to lay eggs on its host in the laboratory failed. Examination of long-term pupae which had been parasitised suggests that at least some of the flies diapause as larvae which pupate a few days before emergence of the adult.

A braconid parasite was recorded for the first time in Northern Nigeria from red bollworm. This was *Apanteles* sp. (probably *A. diparopsidis* Lyle), taken as white cocoons both inside and outside bolls showing red bollworm damage. The host had been killed in the second or third instar by the parasite, and this was confirmed from infested bollworms collected in the field. In one case two parasites emerged from one host, and the parasitism rate in the field was up to 5%.

Three specimens of *Eurytoma* sp. (Hymenoptera, Eurytomidae) were taken from third instar red bollworms. Eurytomids have not been recorded previously as parasites of red bollworm, although *E. braconidis* Ferr. is reported as a hyperparasite of *D. watersi* in the Sudan.

Specimens of mermithid nematodes taken as parasites of *D. watersi* were forwarded for examination from I.R.C.T., Tikem, Tchad, A.E.F. At this station the nematodes, which are up to 30 cms. in length, infect as many as 40% of red bollworms in September. This apparently important parasite has not been found at Samaru.

Many laboratory cultures of red bollworm at Samaru were killed by a contagious disease, probably caused by a virus; further work on this disease, including field contagion trials, will be carried out when time permits.

Other bollworms.—Spiny bollworm (*Earias biplaga* Walk.) cocoons were found to be heavily parasitised by *Carcelia* sp. and by *Brachycoryphus* sp. (Hymenoptera, Ichneumonidae), parasitism rates at Daudawa being 10% and 20% respectively.

Heliothis armigera (Hb.) was locally abundant at Daudawa during October. Many nests of mason wasps were found in the vicinity of the infested fields, built mainly on trees, and it was found that, in nearly all cases, this bollworm was used as the larval food. Since there must have been many thousands of nests in the vicinity, this predator must have been an important factor in the control of this bollworm.

No parasites were recorded from pink bollworm (*Platyedra gossypiella* (Saund.)), but a mite fed on and killed these larvae in the laboratory.

Sylepta derogata (*F.*). *Cotton leaf roller.*—This minor pest was controlled by its parasites *Apanteles syleptae* Ferr. and *Cremnops* sp. (Hymenoptera, Braconidae). *Syntomosphyrum* sp. (Hymenoptera, Eulophidae) was recorded as a hyperparasite of *Apanteles syleptae*.

Dysdercus superstitiosus (*F.*). *Cotton stainer.*—This is by far the most common stainer in Northern Nigeria, and was a serious pest of early sown, well grown cotton in 1958.

It was successfully cultured in the laboratory throughout the dry season for studies on its biology. During this work, a case of what may be termed nymphal albinism was recorded. Breeding and selection indicated that this albinism was probably due to a recessive gene.

Preliminary laboratory trials on the effect of DDT and BHC on stainers have confirmed the field observations that BHC gives a quick knockdown (under fifteen minutes) compared with the much longer period (several hours) for DDT. There appeared to be no synergistic effect using a BHC/DDT mixture, the speed of knockdown being approximately dependent on the concentration of BHC. DDT deposits retained their toxicity much longer than BHC. Fresh BHC deposits were toxic to stainers at a fraction of the estimated concentration used in the field.

Observations on the occurrence of stainers on alternative hosts showed that further information is required on the whereabouts of this pest during late February and early March. At this period no stainers can be found, but by mid March adults appear in considerable numbers on and around kapok trees.

Although dipteran eggs have been found attached singly to the cuticle of cotton stainers, no adult parasite has yet been obtained.

Oligonychus gossypii Zacher (*Acari, Tetranychidae*).—This spider mite was found at several stations towards the end of the season on sprayed cotton, probably because the parasites and the predators which normally keep it under excellent control were killed by the insecticides. Its effect on yield appeared in most cases to be small, but future outbreaks will obviously have to be carefully observed.*

Aphis gossypii Glov. Cotton aphid.—Aphids became very common on some sprayed fields at Daudawa after applications of insecticides had ceased. Coccinellids, and larvae of Syrphidae and of Neuroptera, were actively controlling the outbreaks soon afterwards.

We are indebted to the Commonwealth Institute of Entomology for all identifications.

Insecticide Trials.

(i) *Samaru and Shika, Zaria Province.*—At Samaru and Shika, several trials laid down by the cotton breeder and agronomist received insecticide treatments during the season to enable a clearer picture of the effect of fertilisers, mulching and other cultural treatments to be obtained; without some degree of protection from pest damage, the higher potential yields resulting from these treatments tend to be obscured. The insecticides, in most cases in the form of sprays, were applied using either hand-operated knapsack sprayers or "Motoblo" shoulder-mounted sprayers. Details and results are given elsewhere.

Definite recommendations on the amount and type of fertiliser to apply to cotton cannot yet be made. Present indications are that, with unsprayed cotton, or with cotton that is only partially protected against pest attack, there is no economic advantage in applying more than 1 cwt. of superphosphate plus 1 cwt. of sulphate of ammonia per acre. Where the degree of pest control is high, the response to higher dressing is likely to be significant, as with some of the cotton breeders' "best-treated" plots.

(ii) *Daudawa, Katsina Province.*—Nearly half (189 acres) of the cotton on the multiplication farms at Daudawa and Shemi was sprayed at least twice during the 1958-59 season, using tractor-mounted equipment. The sprays, consisting of a mixture of DDT and BHC were applied during September and October; good control of stainers invading the crop at this time was obtained, although later in the season a heavy bollworm attack developed in some fields. Although the fields for spraying were not chosen at random but included the better grown ones (those with heavier stainer attack), the average yields (685 lb. seed cotton per acre sprayed and 366 lb. unsprayed) indicated a very substantial response to spraying. It is concluded that

*See Empire Cotton Growing Review, Vol. 37, No. 3, p. 217 (Letter to Editor).

the whole cost of the operations was more than balanced by the additional seed cotton produced, apart from the value of the extra seed to the multiplication scheme.

Further details have been published in a paper entitled "The application of insecticides on the cotton multiplication farm, Daudawa, during the 1958-59 season."*

(iii) *Lowlands, Plateau Province.*—Although Lowlands, in common with other Riverain areas, experienced a marked shortage of rain from the end of June to the beginning of August, small amounts of rain were recorded at intervals during this period.

(a) In a date-of-sowing trial, the highest yields from sprayed cotton were given by sowings made during the first three weeks of June. (Table 3).

TABLE 3.

EXPT. NO. N8(58). SERIAL SOWING DATE OF COTTON, WITH INSECTICIDE, LOWLANDS, 1958

Sowing date	*Yield of seed cotton lb. per acre*
9th June	1432
16th June	1410
23rd June	1367
30th June	1153
7th July	801
14th July	222
21st July	117
28th July	95
4th August	81
11th August	18

NOTES:

Data from 2 observation blocks each of 10 plots sown serially with cotton (variety 26J) at weekly intervals from 9th June to 11th August.
Plot size: 1/40 acre. Spacing 18" on 3 ft. ridges.
Fertiliser: 1 cwt. superphosphate plus ½ cwt. sulphate of ammonia per acre on virgin land.
Insecticide: 4 applications of 1·5 lb. DDT plus 0·3 lb. gamma BHC in 45 gallons of water at weekly intervals from 8th September.

(b) To confirm that high yields could be obtained from sprayed cotton over larger areas than those possible in plot trials, 4 one-acre blocks of cotton were sown on 16th and 17th June. These were sprayed with 1·5 lb. DDT plus 0·3 lb. gamma BHC at 4 weekly intervals from 10th September to 3rd October. No fertiliser was required as the land used was highly fertile. Final yields from 3 blocks are given in Table 4; the yields of the fourth block were similar, but exact figures were not recorded.

*Supplement to News Letter, No. 7, March 1959 (Research and Specialist Services Division).

TABLE 4.

EXPT. N8(58). COTTON EXTENDED AREA SPRAYING TRIAL, LOWLANDS, 1958.
(*Yields of seed cotton in lb. per acre*)

	Block A	*Block B*	*Block C*
1st picking (27/10-29/10)	600	544	653
2nd picking (11/11-14/11)	781	677	595
3rd picking (24/11-25/11)	171	132	112
All pickings	1552	1353	1360

Mean yield of 3 × 1 acre blocks—1,422 lb./acre (77% clean)

In this and the date-of-sowing trial, the course of pest incidence was similar to that recorded in previous seasons; a few stainers appeared in the crop during August but the insecticide restricted populations to a low level until mid October. Then numbers of adults and nymphs increased rapidly to a peak (7,000-10,000 adults per acre) in mid November. Bollworm damage increased from the beginning of November, mainly because of the presence of pink and red bollworms. Nearly all of the green bolls remaining in the field at this time were damaged by both bollworms and stainers. The effect of these pests on the final yield was probably relatively small, as the greater part of the crop had been harvested by mid November. (Table 4).

(iv) *Mokwa, Niger Province.*—(a) Confirmation that, with subsequent spraying, mid June sowings give the highest yields was obtained from an observation trial in which the sowing dates extended from mid May to mid July. (Table 5).

TABLE 5.

EXPT. X3(58). SERIAL SOWING DATE OF COTTON, WITH INSECTICIDE, MOKWA, 1958
(*Yields of seed cotton in lb. per acre*)

Sowing dates	*Yield*
12th May to 20th May	217
22nd May to 30th May	549
1st June to 9th June	721
11th June to 19th June	1028
21st June to 29th June	847
1st July to 9th July	621
11th July to 15th July	166

NOTES:

Data from two observation blocks each of 33 plots sown serially with cotton (variety 26C) at 2-day intervals from 12th May to 15th July.

Plot size: 12 yards × 2 ridges, 2½ feet apart.

Insecticide: 6 applications of 1 lb. DDT plus 0·3 lb. gamma BHC as spray at weekly intervals from 8th September.

Germination, and the early development of the cotton plants in this trial, were seriously affected by the lack of rain during early May and in July. The total number of stands remaining at harvest for

sowings made up to early June was only 13% of those sown; it is probable, therefore, that higher yields would have been given by the sowings made before mid June if higher stand counts had been obtained.

(b) In a large scale spraying trial, carried out to determine whether insecticidal control of cotton pests would be economic at Mokwa, 29 fields covering just over 100 acres were divided into 6 groups. The fields in each group (with the exception of one omitting treatment A) received one each of the following treatments:—

A. (5 fields, 20·2 acres gross; 17·3 acres nett.) 1 lb. DDT + 0·3 lb. gamma BHC per acre; 6 applications at weekly intervals from 8th September.

B. (6 fields, 21·6 acres gross; 18·7 acres nett.) 1 lb. DDT + 0·3 lb. gamma BHC per acre; 5 applications at 8-day intervals from 9th September.

C. (6 fields, 20·9 acres gross; 17·9 acres nett.) 1 lb. DDT + 0·3 lb. gamma BHC per acre; 4 applications at 10-day intervals from 10th September.

D. (6 fields, 22·7 acres gross; 19·6 acres nett.) 0·25 lb. endrin per acre on 9th September; 4 applications of 0·1 lb. endrin per acre at 8-day intervals from 17th September.

E. (6 fields, 20·8 acres gross; 17·8 acres nett.) 0·25 lb. endrin per acre on 8th September; 0·1 lb. endrin per acre on 22nd September and 6th October.

Each field contained 48 ridges of cotton and the difference between the gross and nett areas occurs because two ridges were left unsown at 12-ridge intervals to allow for the passage of the tractor-mounted sprayer.

Eight of the smaller fields, totalling 8·6 acres, were sown mechanically on 16th and 17th June; the remaining fields were sown by hand between 12th and 27th June. All the fields had been under bush fallow for three years; owing to administrative difficulties, no fertiliser was applied.

Germination and early growth of the crop were depressed by an abnormally prolonged dry spell which lasted from 23rd June to 6th August, and during the remainder of August there was only 2·56 inches of rain. The first-sown fields were better able to survive the drought than those sown later. Although the crop as a whole improved considerably during late August and September, it never completely recovered from this setback. This is reflected in the yields. (Table 6).

Sprays were put on with a Cropguard Senior sprayer, fitted with a 100 gallon tank, and with booms extending to 32 feet, mounted on a

Massey-Ferguson 35. Using ceramic jets size 000 and a spraying pressure of 40 p.s.i., it was possible to apply 9-10 gallons per acre, when the tractor was moving at 3-3¼ m.p.h. The boom supports were modified to enable the boom to be raised, and the centre jets were blocked off. The tractor moved down the unsown ridges in each field, spraying six ridges on either side at each traverse.

The sprays were timed to control the first immigration of stainers into the cotton; these insects first appeared at the end of August, and reasonable control on all treatments was obtained until the last spray was applied. Numbers then increased, and by mid November about 10,000 adults per acre, with many nymphs, were present.

During the period of spraying bollworms occurred in the crop in small numbers, but populations increased rapidly from the beginning of November. Pink bollworms were by far the most common, being found in 70-80% of green bolls examined during mid November. Red and spiny bollworms and the larvae of the false codling moth were also present.

A red spider mite, *Oligonychus gossypii,* was found on all fields at the end of October, and during November some defoliation was caused; by mid December the incidence of this pest had decreased.

Picking began at the end of October and continued until December; the mean yields from each treatment, based on the nett area of cotton, are given in Table 6.

TABLE 6.

EXPT. NO. X20(58). COTTON LARGE SCALE SPRAYING TRIAL, MOKWA, 1958.
(*Yields of seed cotton in lb. per acre*)

Treatment	*Yield*	*Percentage of clean cotton*
A	484	67
B	493	63
C	486	59
D	402	47
E	341	39

Results of work in previous years had indicated that yields higher than those obtained could be expected; some factors tending to reduce yields this season were:—

(1) Nearly seven weeks without rain early in the season.

(2) Lack of fertiliser: the results of an N and P trial carried out at Mokwa during the season suggest that the application of 1 cwt. of superphosphate and ½ cwt. sulphate of ammonia per acre would probably have increased yields by between 150 and 200 lb. seed cotton per acre. (See Table 7).

(3) Sowing dates extending from the middle to the end of June. The mean yield of an early sown group of fields containing each

treatment was 579 lb./acre, and that from a later sown group was 344 lb./acre. This difference was reinforced by a fertility gradient which was lowest on the later sown fields.

(4) Pest damage from bollworms, cotton stainers, and possibly red spider mites, after the completion of the spraying programme. Pests had a relatively greater effect because lack of rain and fertiliser at the beginning of the season reduced the number of fruiting bodies produced during the period of spraying.

With such low yields, the value of the seed cotton obtained from the best and cheapest treatment (C—four sprays applied at 10-day intervals) did not cover the cost of growing and spraying the crop. Costs were higher than economically necessary since the experimental layout prevented the most advantageous use of land and tractors, and picking costs were abnormally high owing to the use of inexperienced labour. Detailed costings are too involved to discuss here, but in the circumstances, the results must not be interpreted as showing that cotton growing and spraying at Mokwa would prove uneconomical. A similar trial is to be carried out during 1959-60.

(c) The results of an N and P trial on cotton are given in Table 7. Although there has been some response to the lower rates of application, no interpretation will be attempted until the results of further trials at this and other stations have been obtained.

TABLE 7.

EXPT. X2(58). COTTON N AND P TRIAL WITH INSECT CONTROL, MOKWA, 1958
(*Yields of seed cotton in lb. per acre*)

	N_0	N_1	N_2	N_3	Means (S.E. ± 34)
P_0	480	739	962	747	732
P_1	733	685	909	899	806
P_2	825	908	857	918	877
P_3	660	879	691	1047	819
Means (S.E. ± 34)	675	803	855	903	809

NOTES:

Sowing date: 16th June.
Layout: 4 randomised blocks of 16 plots.
Fertiliser levels: (a) N_0 N_1 N_2 N_3, sulphate of ammonia at 0, 1, 2 and 3 cwt. per acre applied 6/8/58.
(b) P_0 P_1 P_2 P_3, superphosphate at 0, 1, 2 and 3 cwt. per acre applied on ridges before sowing.
Insecticide: 1 lb. DDT plus 0·3 lb. gamma BHC per acre, in 10 gallons of water, applied 6 times at weekly intervals from 10th September.

(v) *Other stations in Riverain provinces.*—Observation trials of a very simple design ($\frac{1}{2}$ acre of cotton sprayed; $\frac{1}{2}$ acre unsprayed) were carried out at Abuja (Niger Province), Loma (Ilorin Province), Otukpo

(Benue Province), Gombe (Bauchi Province) and Beli (Adamawa Province). Basic instructions for these trials were that they should be sown in mid June, that 1 cwt. superphosphate and $\frac{1}{2}$ cwt. sulphate of ammonia should be applied, and that a series of 6 weekly sprays (1·5 lb. DDT plus 0·3 lb. gamma BHC) should be given from about 10th September.

Though in most cases there was a marked response to the insecticide treatments, yields were disappointingly low, and in no case exceeded 500 lb. seed cotton per acre. The major reason for this was the lack of rain during the vital early part of the growing season, which reduced germination and retarded the early development of the cotton.

These trials provided a good demonstration of the care that must be taken if insecticide treatments are to achieve their objective; cotton to be sprayed must be sown by mid June on well prepared, fertile soil, and insecticides must be correctly applied. Provisional recommendations for use by Provincial Agricultural Officers have been issued embodying these points.

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PROGRESS REPORTS FROM EXPERIMENT STATIONS.

The reports for the seasons up to and including 1950-51 were published in seasonal volumes; the following are still in print and available at 3/- per volume post free.

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1935-36, 1942-43 and 1945-46 to 1950-51.

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